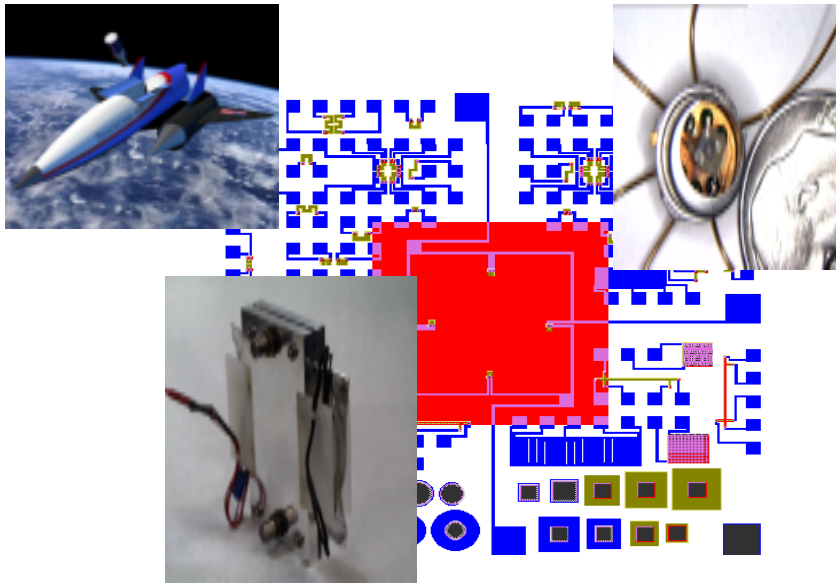
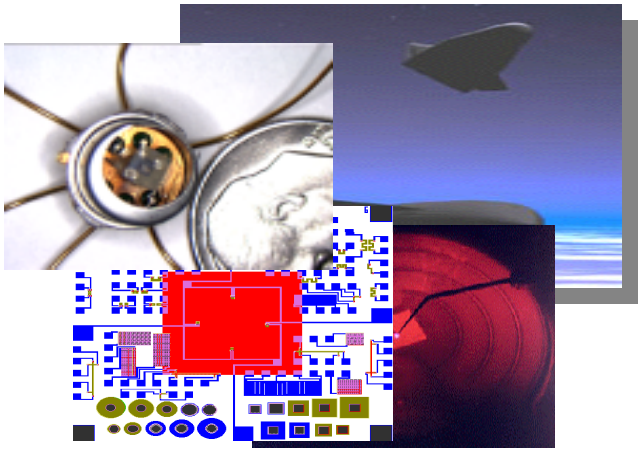
Launch Technologies Project

- **Project Objectives:**
  Provide basic launch technology building blocks to enable significant improvements in safety and reliability of transportation systems while reduce in the life time cost.

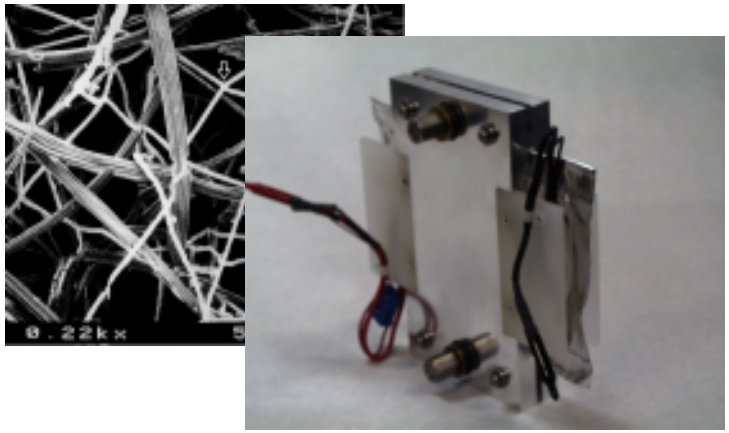


- **Technology Objectives:**
  - **Design, develop and test advanced avionics, power systems, power control and distribution components and subsystems for insertion into a highly reliable and low-cost system for a reusable launch vehicle.**
  - **Develop integrated design and analysis tool technologies.**
  - **Develop and test a safe and operationally viable aerospace vehicle Crew Visibility System concepts and Payload Systems.**

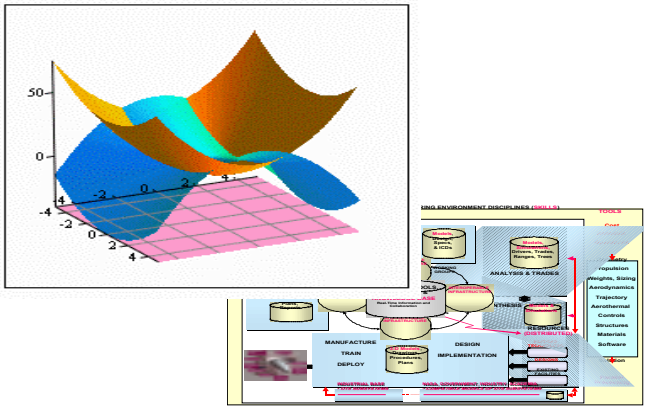
Launch Technologies Elements



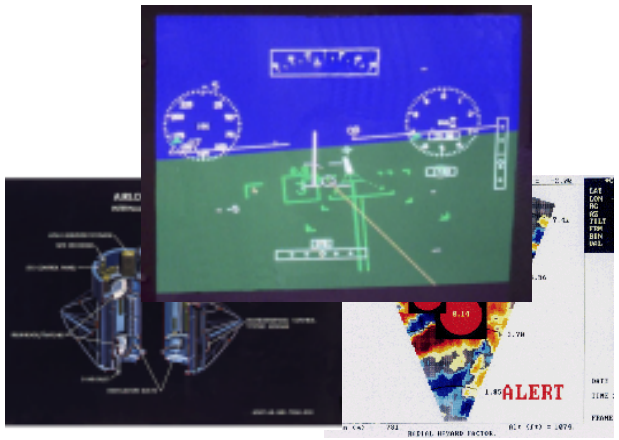
Avionics and Flight Control
Lead Center - MSFC



Power
Lead Center - GRC



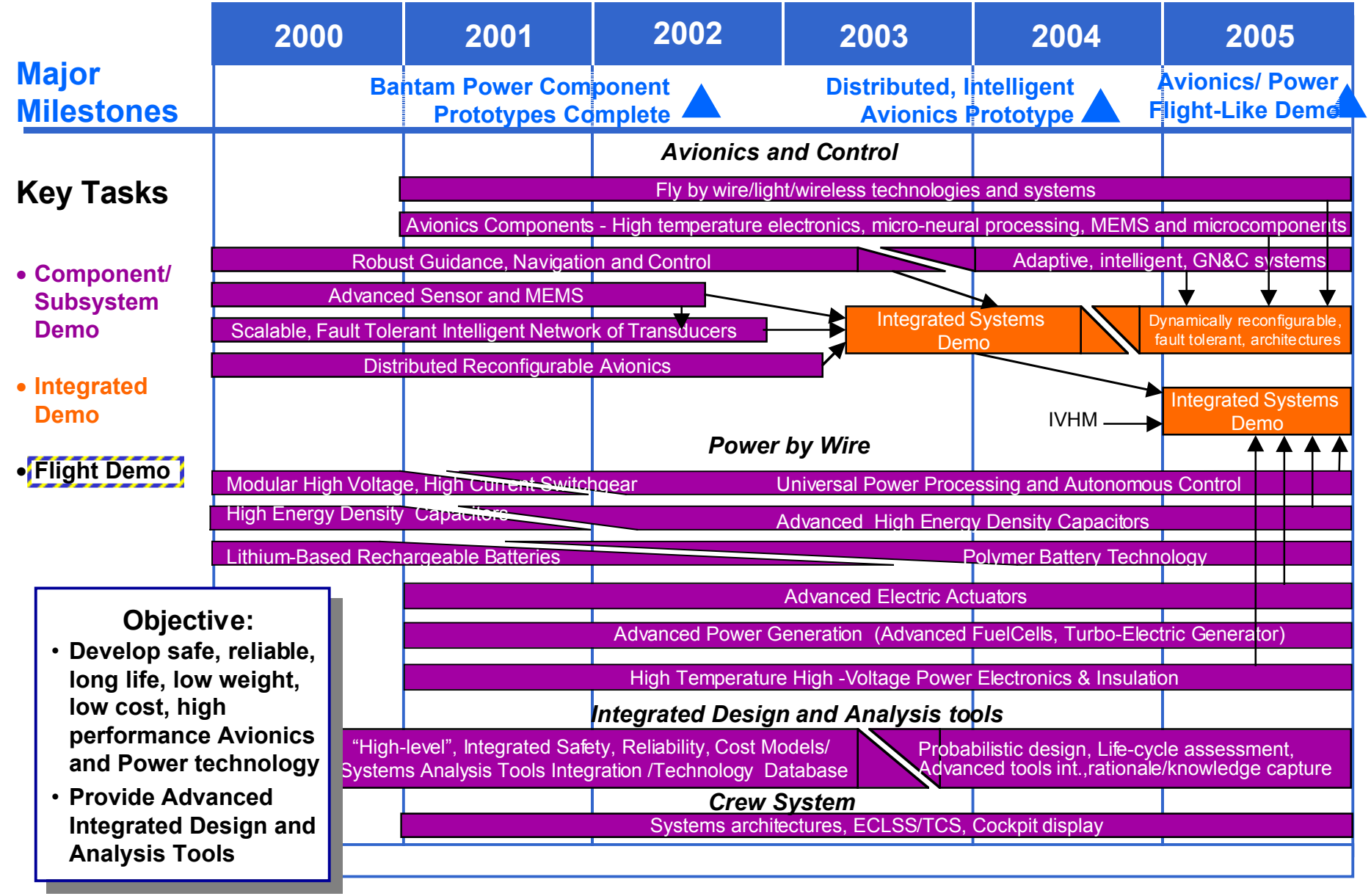
Integrated Design and Analysis tools
Lead Center - MSFC



Crew Systems
(No FY00 Funding)

Launch Technology Roadmap

Launch Technologies Project — 2000 PMC



Objective:

- **Develop safe, reliable, long life, low weight, low cost, high performance Avionics and Power technology**
- **Provide Advanced Integrated Design and Analysis Tools**

5536.4

Bantam Technologies *are the First Steps* of the Critical 3rd Generation Spaceliner Blueprint

Advanced Operations
- Automated Umbilicals
- Autonomous Flight Safety System
- Mag Lev Launch Assist

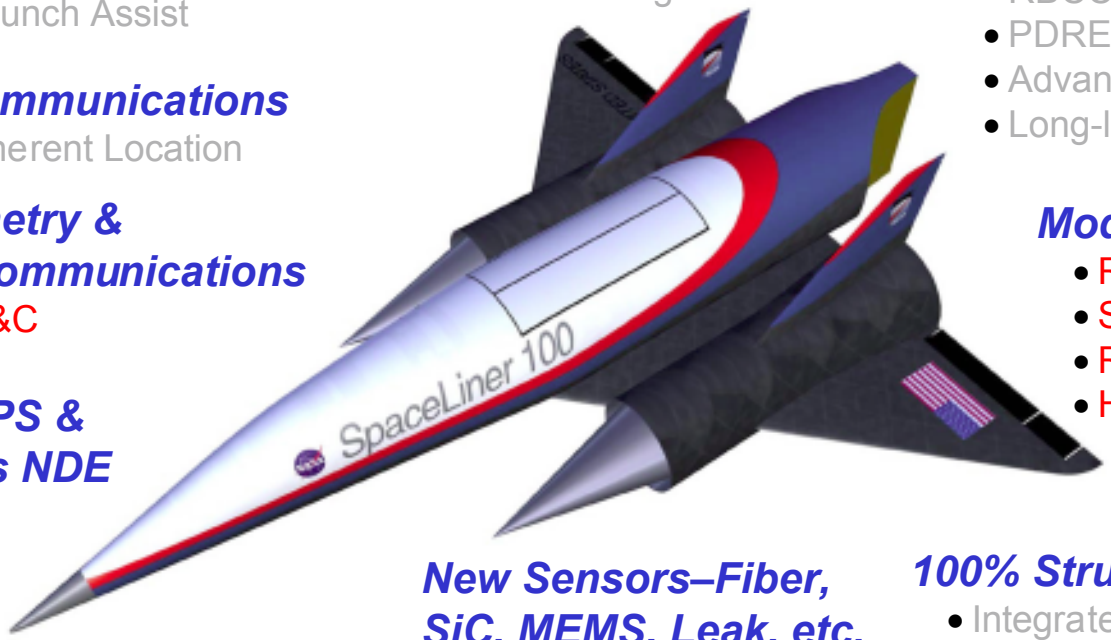
Wireless Communications
- Passive Coherent Location

Smart Telemetry & Advanced Communications
- Robust GN&C

Intelligent TPS & Autonomous NDE
- Smart TPS

Distributed Active Control & Self Healing Airframes & Surfaces
- Smart Sheet Sensors

Integrated Propulsion Health Management
- IVHM Diagnostic S/W



Advanced Propulsion Systems
- RBCC
- PDRE
- Advanced Propellants
- Long-life Rocket

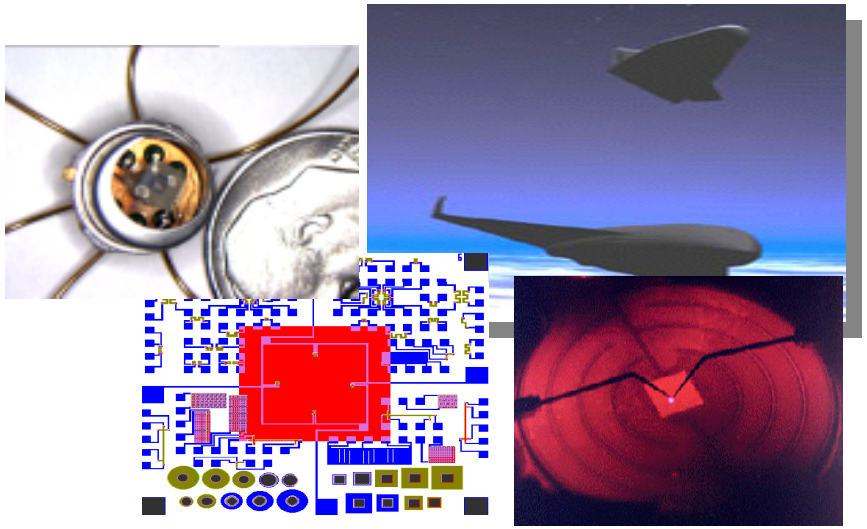
Modular Distributed Avionics
- Reconfigurable Avionics
- Super Capacitors
- Rechargeable Lithium Batteries
- High Voltage Switch Gear

New Sensors–Fiber, SiC, MEMS, Leak, etc.
- High Density Structural Sensors
- Smart, Multi-function Sensor Development

100% Structural & TPS Coverage
- Integrated MPS Cryotank
- Ultra High Temp PMC's
- Advanced Adhesives & Sealants
- Non-Autoclave Fabrication of PMC's
- CMC Life Prediction
- Ultra High Temp Leading Edges
- Low-cost, Erosion Resistant TPS
- Advanced Stitched Composites
- Composite LOX Tanks

Legend:
- *Spaceliner Critical Technologies*
- **Bantam Technologies moved to Launch Technologies Proj.**
- **Other Bantam Technologies**

Avionics and Flight Control



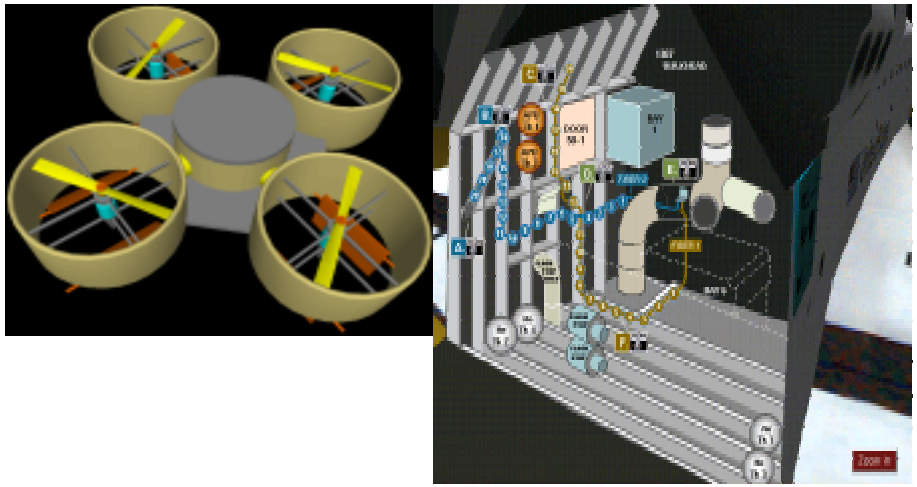
Long-term major goals:

- **Develop avionics and flight control technologies to enable highly reliable, lightweight, low power, avionics …..and control systems.**
  - **Dynamically reconfigurable, fault tolerant, architectures**
  - **Adaptive, intelligent, guidance, navigation and control systems.**
  - **Fly by wire/light/wireless technologies and systems**
  - **High temperature electronics, micro-neural processing, MEMS and microcomponents.**

Avionics and Flight Control

Description of Technology

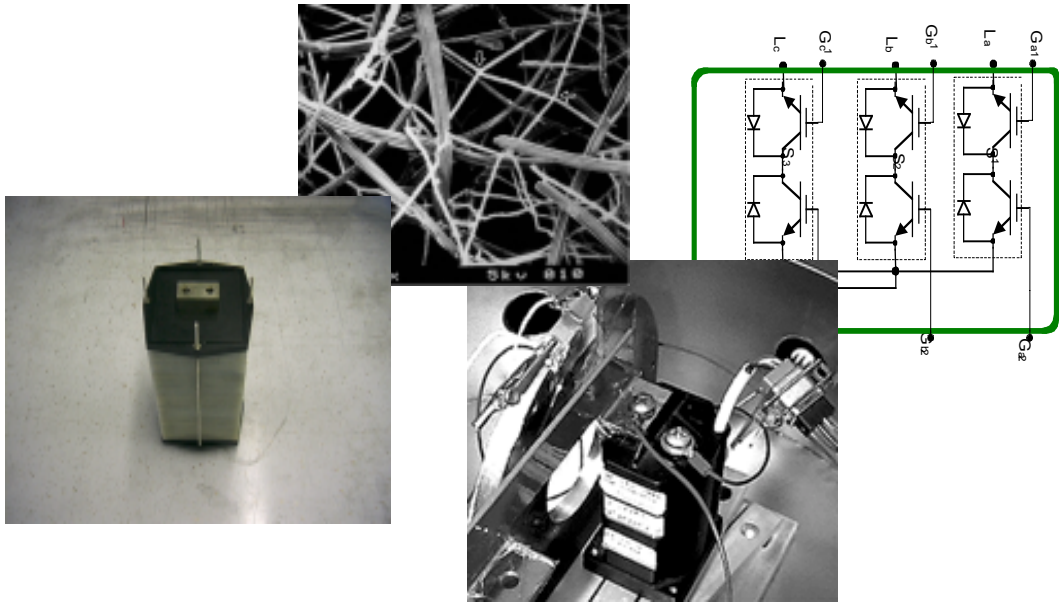
- Distributed Reconfigurable Avionics (DRA)
- Robust Guidance, Navigation and Control
- SFINX (Scalable, Fault-tolerant Intelligent Network of Xducers)
- Advanced Sensor and MEMS
- High Density Structural Sensors
- Smart Sheet



Participants:

MSFC, ARC ,LaRC, GRC, KSC, Lockheed Martin , Case Western Reserve, Draper Laboratories, Oak Ridge National Laboratories, Makel,University of Alabama, Stanford University

Power Systems



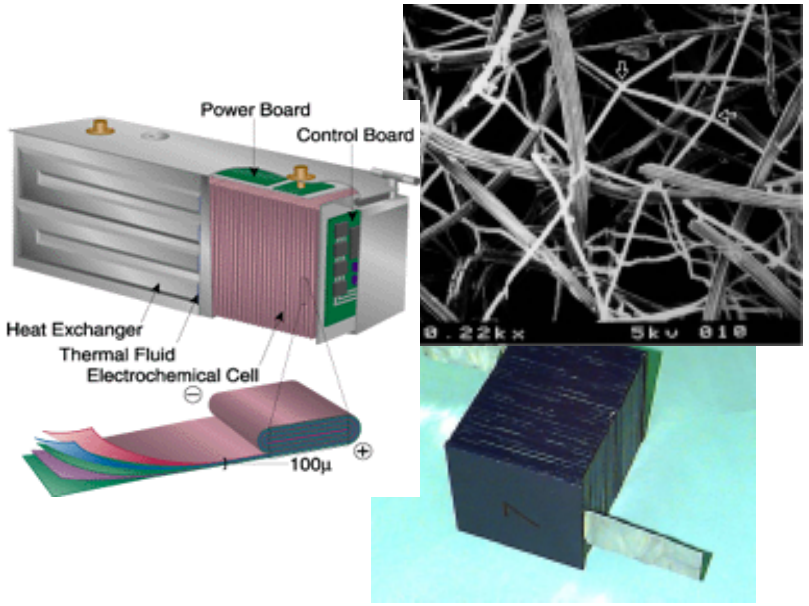
Long-term major goals:

- Develop high power Electrical Power System (EPS) technologies and system architectures.
  - High energy and specific power battery technology
  - High energy and power density capacitors
  - Power Management and Distribution components and systems

Power Systems

Description of Technology

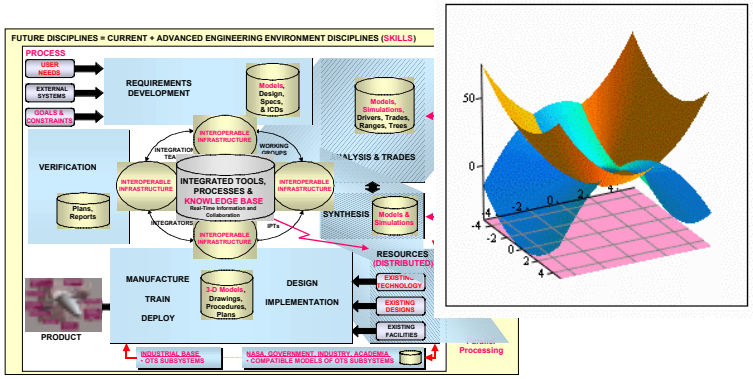
- Super Capacitors
- High-Energy Density Electrochemical Capacitors (ECs)
- Lithium-Based Rechargeable Batteries
- Modular High Voltage Switchgear



Participants:

GRC, MSFC, Naval Surface Warfare Center, Lockheed Martin, Auburn University Space Power Institute, Eagle Picher Industries, T/J Technologies, Alliant Technical Systems, Lithium Technologies Corp, 3M- HydroQuebec, Sunstrand, TRW, JME

Analysis and Design Tool Development

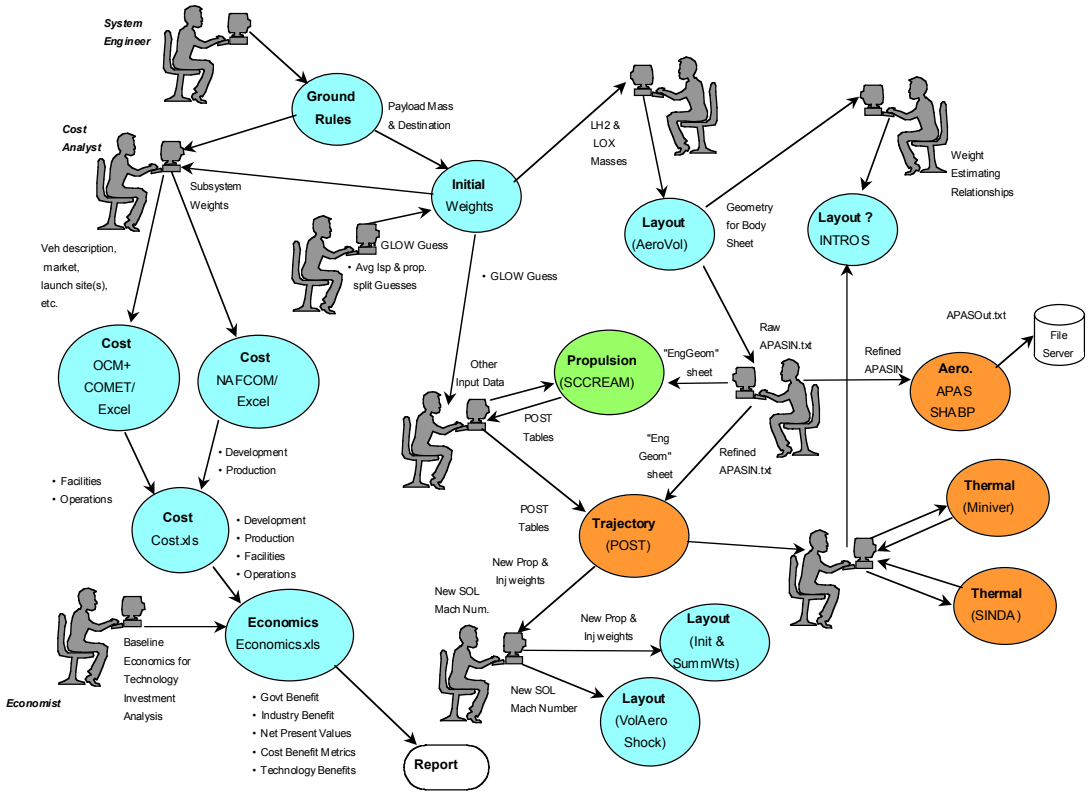


Long-term major goals:

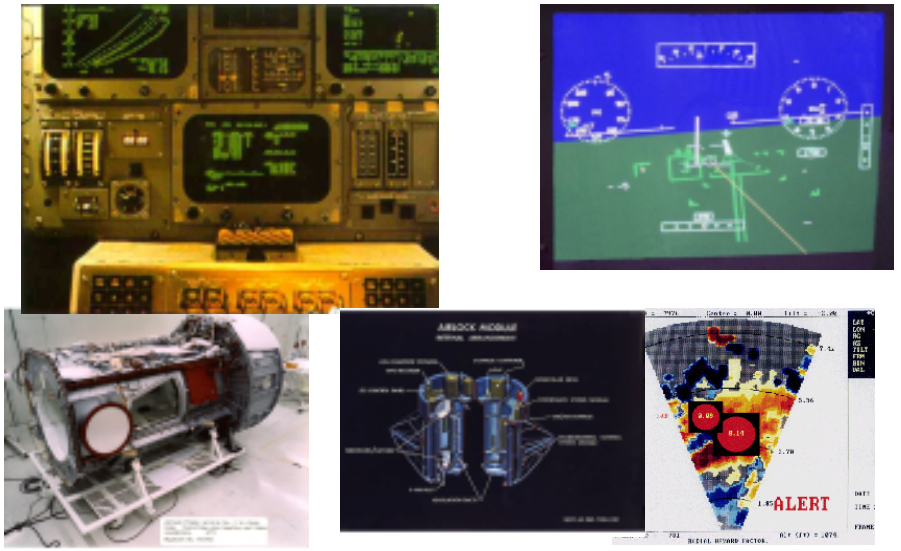
- Develop probabilistic design systems for multiple design alternatives -- understanding and reducing risk/uncertainty.
- Develop Life-cycle assessment tools -- bringing cost, safety, and reliability into the design phase.
- Integrate advanced design and analysis technologies leading to substantial reductions in systems analysis and design cycle time.
- Development of rationale/knowledge capture -- record the why as well as the what.

Analysis and Design Tool Development

- **Description of Planned FY00 Technology**
  - **Integrated Life-Cycle Cost/Risk Estimation Model**
  - **Pilot Integrated Design Environment System**
  - **Technology and Engineering Application Management System**



Crew Systems



Long-term major goals:

- Development of safe and operationally viable aerospace vehicle Crew Visibility Systems concepts.
- Development of associated technologies, data, and guidelines to enable space crew operations in all levels of flight conditions.

Major Accomplishments 99/00

Date		Progress	
Planned	Actual	Accomplishment	Significance
3/00	8/99	• Tested and demonstrated a prototype sensor package to measure hydrocarbons. Sensor Package includes hydrocarbon sensor with a temperature detector and heater.	Demonstrated the ability to packages and operate a hydrocarbon sensor. Measured Methane and Ethylene in temperature ranges greater than 400C.
6/99	8/99	• Completed High Energy Density Electrochemical Capacitors power/energy requirements definitions & system trades.	Concluded stand-alone operation is not the best use of this technology. Best use is in combination with Battery or Fuel Cell. Study suggests 40% weight savings over Battery-alone system
11/99	11/99	• Characterized 29 dielectric films in terms of 28 electrical and mechanical properties.	Data is being utilized to select substrate(s) to develop multi-layer flexible substrate, capable of supporting embedded electronic die.

Milestone Status

Milestone # 1: Electrochemical Capacitor (EC) Evaluation

G

- **Planned Completion Date:** February, 2000
- **Milestone:** Complete evaluation of high power density Electrochemical Capacitor (EC) technologies.
- **Output:** Selection of two out of 14 Electrochemical Capacitor (EC) technologies to pursue in the development of a, 30 kW/kg power density/ 3Whr/kg energy density, power system.
- **Outcome:** Significant reduction in the weight, up to 40 %, of future launch vehicle power storage systems possible when high power density Electrochemical Capacitors technology are used in conjunction with batteries or fuel cells.
- **Status:** JME completed evaluation of 11 EC samples from Redox, Danionics, Pinnacle, T/J, C & T and ESMA, Hyperion, KTI, Giner, Aerovox and Elit. JME is compiling test data for a report due at the end of the month. A team meeting is scheduled to be held at GRC the week of January 24th to discuss findings and down select two technologies.

Milestone # 2: Super Capacitor Fabrication

G

- **Planned Completion Date:** June, 2000
- **Milestone:** Manufacture and test a prototype 30 V, 10 F Nickel Carbon electrode Chemical Double Layer Super Capacitor.
- **Output:** Electrical, and environmental test data demonstrating Super Capacitors can operate in Solid Rocket Booster environments. Electrical data is a projection of needs for proposed Electric APU and Electromechanical Actuation applications.
- **Outcome:** A hybrid power source utilizing super capacitors and traditional batteries will provide significant weight savings over battery alone configurations of at least 50%.
- **Status:** Raw material procured. Electrode fabrication started.

Milestone Status

Milestone # 3: Guidance Navigation and Control Systems Evaluation Lab

G

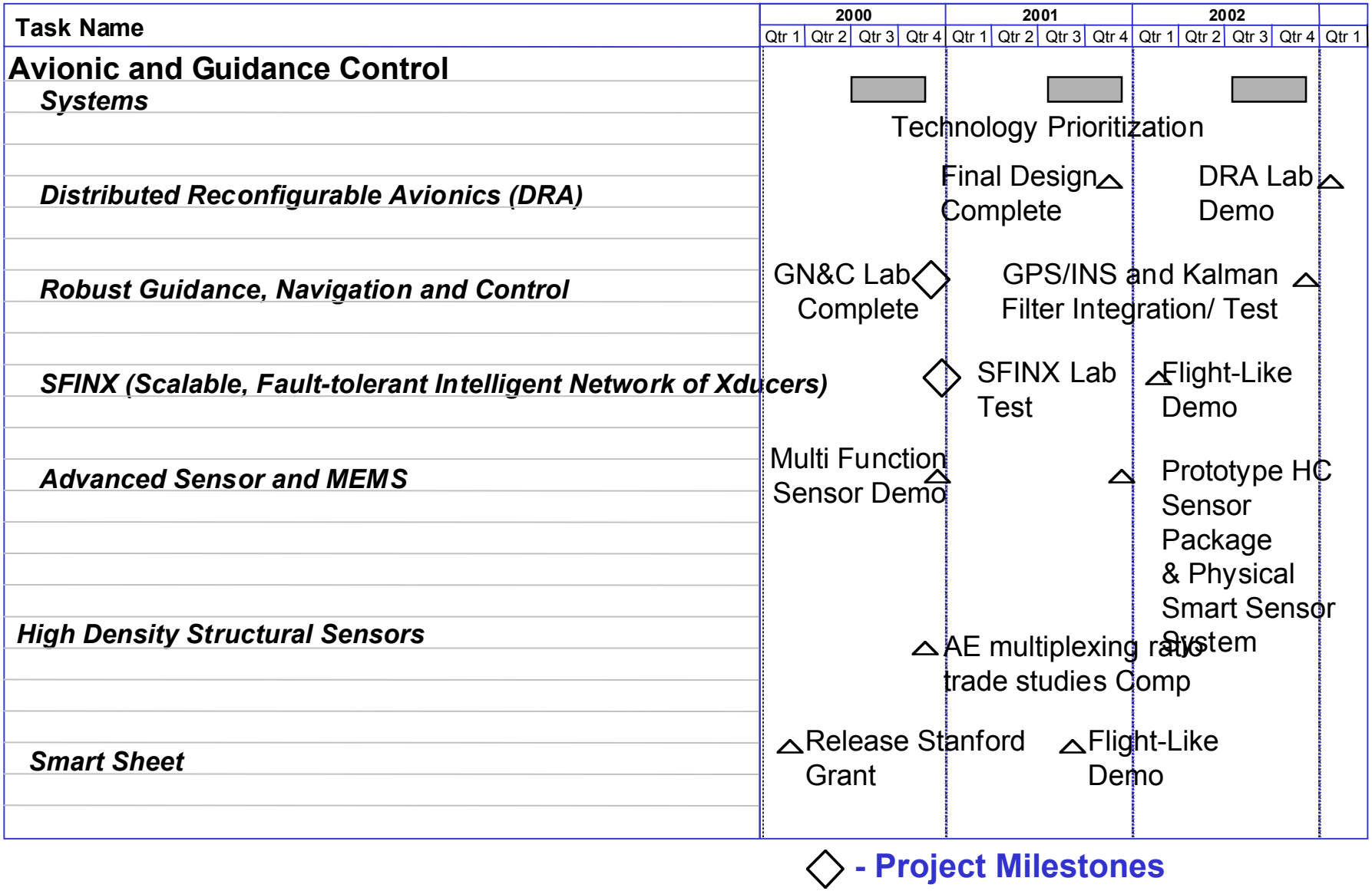
- ***Planned Completion Date*:** Sept, 2000
- ***Milestone*:** Complete the Guidance Navigation and Control Systems Evaluation Lab.
- ***Output:*** Demonstrate the capability to test and validate GPS/IMU systems and conduct real time navigation solution tests.
- ***Outcome:*** Capabilities will enable the development and test of advanced antonymous vehicle guidance, navigation and control systems.
- ***Status:*** Simulation computer, software development workstation and the GPS simulator have been received and hardware is being integrated into the evaluation lab. Three GPS receivers were ordered and two have been received.

Milestone # 4: Scaleable Fault-tolerant Intelligent Network of Transducers

G

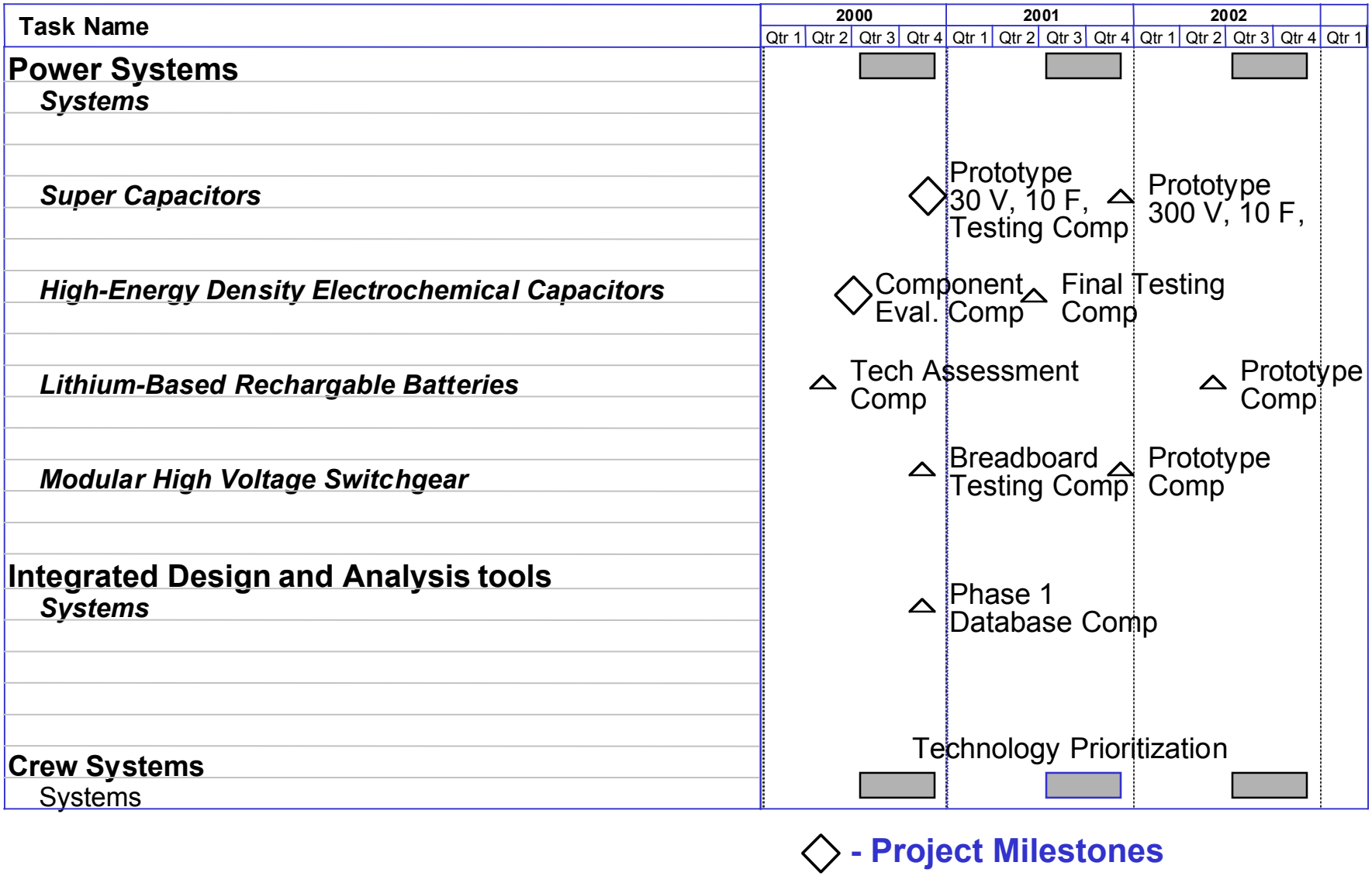
- ***Planned Completion Date*:** Sept, 2000
- ***Milestone*:** Laboratory test of a Scaleable Fault-tolerant Intelligent Network of Transducers hardware concept.
- ***Output:*** Demonstrate four intelligent I/O components (sensors and actuators) including electronics to interface the components to a transducer bus. The bus (coax) will provide both power and communications to the I/O components using modified IEEE 1451 smart sensor standards.
- ***Outcome:*** Significantly reduce avionics weight, simplify fault-tolerant architecture design to any level of redundancy up to quad systems, eliminate wiring and associated connectors, provides enhanced built-in-test and health management functions, automate checkout, diagnostics, and repair processes, minimize system size, weight, power, and cost
- ***Status:*** Completed concept reviews, system design and preliminary electronics designs. Completed system and component specifications. Finalizing hardware and software design and performing flight-like package size analysis.

Schedule



◇ - Project Milestones

Schedule (continued)



◇ - **Project Milestones**

Development Launch Technologies Tools

Description

- Develop an integrated cost/risk estimating and analysis tool, including life-cycle models, capable of performing technology impact, design and requirements trades.
- Develop a technology data/knowledge management system capable of fusing data between NASA Centers, DOD, and industry and providing intelligent assistant.
- Develop an integrated design environment capable of interfacing multiple analysis and design tools to facilitate productivity and shorten vehicle analysis and development cycle.

Approach

- Integrate Launch Technology Tools development plan with an Agency Wide Space Transportation Tools Development Plan.
- Utilize AEI and ISE proposals as well as work with other NASA center, industry and academia in development of a detail requirement document and project plan for tools development.
- Select contractors to develop tools and integrate tools.

Launch Technologies Tools Development

♦ Technical Challenges

- Development of state of the art modeling and analysis tools.
- Integration of existing as well as newly developed tools.